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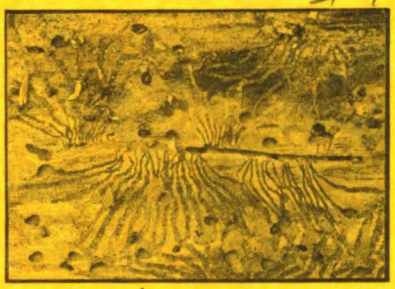

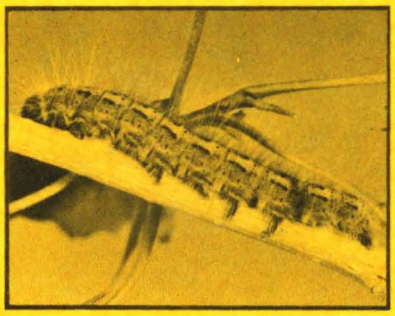

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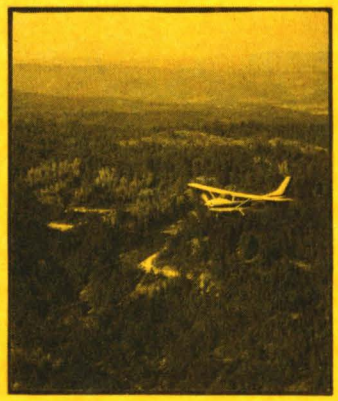
EVALUATING A MOUNTAIN PINE BEETLE INFESTATION WITH 35MM AERIAL COLOR PHOTOGRAPHY



FOREST INSECT AND DISEASE MANAGEMENT
STATE AND PRIVATE FORESTRY
U. S. FOREST SERVICE
OGDEN, UTAH

May 1976

By

WILLIAM H. KLEIN

EVALUATING A MOUNTAIN PINE BEETLE INFESTATION WITH 35MM AERIAL COLOR PHOTOGRAPHY

REPORT NO. 4

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EVALUATING A MOUNTAIN PINE BEETLE INFESTATION WITH 35MM AERIAL COLOR PHOTOGRAPHY

Report No. 4

INTRODUCTION

This is the fourth in a series of reports describing the annual trend of lodgepole pine, Pinus contorta Dougl., mortality caused by the mountain pine beetle, Dendroctonus ponderosae Hopk., on portions of the Moose Creek Plateau, Targhee National Forest, southeastern Idaho. The first survey was in 1972, followed again in 1973 and 1974 (Klein, 1973, 1974 and 1975).

Since this is only one in a series of almost routine surveys, the mention of methods and procedures in this report will appear redundant to some, but is necessary to inform those readers who have access only to this report. The only significant departure from past procedures, other than results, was a different method of determining photo scale.

The methods used in this survey are, for the most part, similar to those of the three previous surveys, and are based on the premise that lodgepole pine killed by the mountain pine beetle can be detected and quantified using large scale 35MM color aerial photography (Klein, 1973). By using sequential photography and double sampling techniques, it is possible to record the trend of lodgepole pine killed by the mountain pine beetle over large areas. On Moose Creek Plateau, within the survey area (Figure 1), the number of trees killed per acre during a four-year period were 0.66 in 1971, 2.74 in 1972, 3.14 in 1973, and 3.26 in 1974. The predicted mortality for 1975, based on data from ground truth plots, is 3.45 trees per acre.

PURPOSE

The purpose of this and previous surveys is to follow the year-by-year trend of mountain pine beetle damage, as evidenced by lodgepole pine mortality, on the Moose Creek Plateau. This will inform the land manager and others with a record of past and present tree mortality, and provide a basis for estimating trend and subsequent tree mortality.

AREA

The survey area, approximately 25,000 acres in size and totally of lodgepole pine type, is on the Moose Creek Plateau in the Targhee National Forest. Elevations range from 7,000 feet in the west to slightly more than 8,000 feet in the east. This area is part of a larger area planned for sale of more than 300 million board feet and currently infested by the mountain pine beetle. As a reaction to the infestation, much of the threatened lodgepole pine on the Plateau has already been harvested (Figure 2).

The area covered by the 1975 aerial photographic survey in relation to the three previous surveys is shown in Figure 1.

METHODS

Some specific details concerning the 1975 survey follow:

Time:	15 September, 11 a.m. to 12:45 p.m. (MDT) 3 October, 11 a.m. to 11:45 a.m. (MDT)
Aircraft:	Cessna turbo 206
Scale:	1:3,300
Camera:	Nikon F (f5.6 @ 1/500)
Lens:	Auto-Nikkor 85mm w/Nikkor LIA Filter
Film:	Kodacolor II - 3 R Enlargements
Calculated Ground Speed:	80 MPH
Plot Size;	Calculated - 4.32 acres; Adjusted - 4.16 acres
Total Number of Plots:	44 (38 within type)

Five parallel flight lines, approximately one mile apart, were flown in a north-south direction at mean elevation. However, strong and inconsistent crosswinds caused drift and overcorrection; consequently, two flight lines crossed and portions of one had to be reflown and rephotographed. Stereo triplets (Figure 3) were taken at approximately one-mile intervals, although on occasion this interval varied to avoid photographing non-type areas, i.e., clear cuts. Cycle interval between exposures for 60-70 percent forwardlap was approximately 5 seconds. The camera was hand-held and kept level by use of a small fisheye bubble secured to its back plate. The shutter was activated manually.

A double sampling system was used. Seven (18 percent) of the 38 plots were ground checked to establish a correlation between photo counts and ground truth. Factors used in plot selection were accessibility, representativeness of the area, and infestation intensity (more than 3 faders). All photo plots were first located on resource photography (1:15,840) and then for scale determination, transferred to 2-inch planemetric and 15 minute U.S.G.S. topographic maps.

Ground truth was obtained during 7-10 and 15 October. Plot corners and boundaries were marked with plastic flagging and string; the plot interior was then separated with stringlines into 1-1½ chainwide lanes for ease of orientation and examination. All recent mountain pine beetle killed trees were located, examined and classified as to (1) 1974 attacks (1975 faders) or (2) new 1975 attacks (will become faders in 1976). All 1974 attacks (1975 faders) that were observed on the photos were mapped. As a check on photo scale, one side of each plot was measured with a topographic tape and clinometer.

Photo scale was calculated for each plot as located on the topographic map and the aircraft altitude. Once scale was determined, plot size was selected from a series of presized templats and transferred to the photos. Since area of each templat was based on a 200 feet elevational difference, it was not possible to select the exact size templat in each case, which resulted in an overall slightly larger plot--4.32 acres. The accuracy of the method was determined from the known photo-ground distances obtained on the seven ground truth plots.

RESULTS AND OBSERVATIONS

As in all of the past surveys, there was a good correlation (r=0.99) between photo and ground counts (Figure 4). The adjustment of the photo sample by linear regression as outlined by Wear, et. al. (1966) follows:

1. Mean tree count on 38 photo plots:

   $\bar{x}_1$ = 12.16 trees per plot

2. Mean tree count on seven plot photo subsample:

   $\bar{x}_2$ = 27.57

3. Mean tree count on seven plot ground subsample:

   $\bar{y}_2$ = 27.29

4. Mean plot size

   Calculated = 4.32 acres
   Adjusted = 4.16 acres

5. Regression equation:

$Y = a + bX = 2.67 + 0.89X$

6. Adjusted mean tree count

$yrd = \bar{y}_2 + b(\bar{x}_1 - \bar{x}_2) = 13.58$ trees per plot.

7. 1974 (1975 fader) attack level (corrected for scale):

3.26 trees per acre

Photo scale was more closely controlled during this survey than in previous surveys. Comparisons of differences between aircraft altitude and elevations taken from topographic maps and those computed from actual ground measurements follow:

ELEVATION DIFFERENCE

Plot	Computed	Topographic Map	Percent Difference
1-2	3265	3060	-6.3
2-12	3474	3320	-4.4
2-16	3611	3480	-3.6
4-35	3222	3120	-3.2
5-40	3170	3240	+2.2
5-42	3099	3000	-3.2
5-44	3886	3600	-7.4
		MEAN DIFFERENCE	-3.7

With only one exception, plot size calculated from topographic maps (4.32 acres), was slightly smaller than the true plot dimensions. This resulted in a slightly larger scale and required a 3.7 percent reduction in plot area (4.16 acres).

Although extensive timber harvest activities have significantly reduced the volume of host material on Moose Creek Plateau, tree killing continues at a gradually increasing rate. The 1974 infestation level was 3.26 trees per acre, only a four percent increase over that recorded the previous year. During the five-year epidemic period, an estimated total of slightly over 13 trees per acre has been killed. A resumé of the five-year mortality trend pattern follows:

Year	Numbers of Mountain Pine Beetle-Killed Lodgepole Pine Per Acre Predicted 1/	Measured	Ave. DBH	Method
1971	--	0.66	12.5	49 photo plots
1972	--	2.74	14.7	44 photo plots
1973	2.23	3.14	12.1	43 photo plots
1974	4.18	3.26	12.9	38 photo plots
1975	3.45	--	12.5	7 ground plots
TOTAL		9.80		

1/ Determined on ground truth plots.

CONCLUSIONS

Tree killing by the mountain pine beetle on Moose Creek Plateau continues but still remains at a relatively low level. Because of the heavy timber cutting program and other factors not conducive to rapidly expanding beetle populations, subsequent tree killing should remain relatively static or start to decline. New attacks (1975) recorded on the seven plot subsample showed an estimated attack level of 3.45 trees per acre, only a slight increase over the 1974 level. Although only a cursory sample, past new attack estimates did not differ markedly from the following seasons aerial photo estimates. Figure 5 shows the five-year trend of tree mortality on Moose Creek Plateau compared to the annual depletion of a low elevation (6500 ft.) in nearby Yellowstone National Park (Parker, 1973). If both trends are similar, the 1975 attack level estimate may be high, and tree killing should decrease slightly. In any event, it is highly improbable that a significant increase will occur!

There is a good reason to suspect that lodgepole stands on good sites will suffer heavier mountain pine beetle-caused damage than stands on poor sites. Amman, et. al. (1973) has shown that tree losses are less in high elevation stands than at low elevations, and concluded that this mortality differential was the result of climate and its effect on the biology of the beetle. To explore this concept further, site is a function of elevation and a combination of other factors, including climate, and the lodgepole stands on Moose Creek Plateau are of a relatively low site class; i.e., for a given age or diameter, the trees are considerably shorter than on good sites.

It has been observed that during any one year of a mountain pine beetle epidemic, large diameter trees produce more beetles than small trees, and that beetle production increases with tree height (Klein, 1976). Stand density is also an important factor, with poorer sites supporting fewer large trees than on good sites. These factors--low density and low form class--coupled with less than favorable climatic conditions are important in the regulation of beetle numbers.

Plans for a fifth photographic survey are uncertain at this time. Because of the heavy clearcutting, it is becoming increasingly difficult to photograph timbered areas. Since 1972, when the survey started, the number of plots in lodgepole type has decreased from 49 to 38, and cutting continues. The decision to continue or terminate the survey will be made during the summer of 1976.

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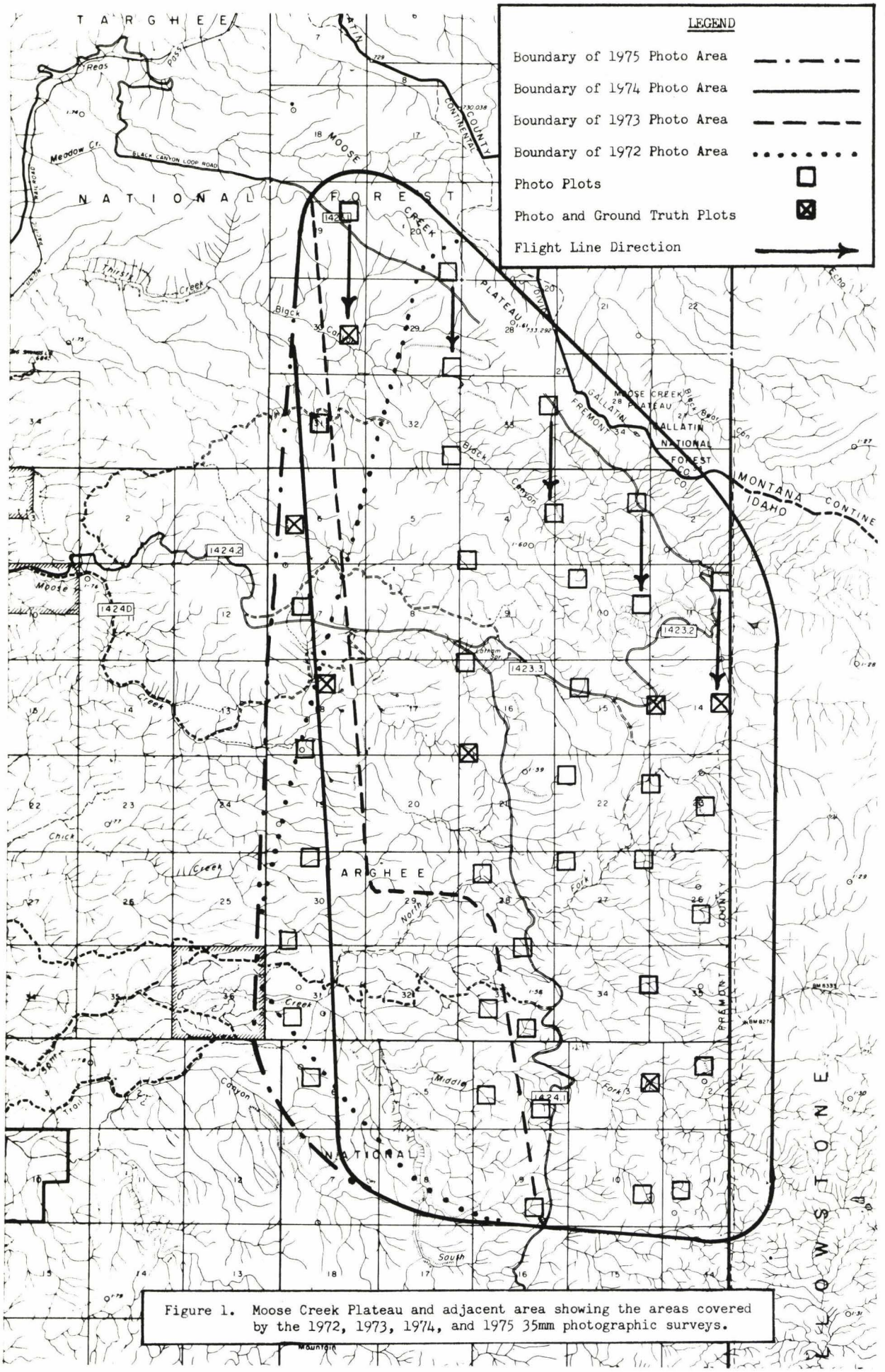

Figure 1. Moose Creek Plateau and adjacent area showing the areas covered by the 1972, 1973, 1974, and 1975 35mm photographic surveys.

Figure 2. Aerial photograph of Moose Creek Plateau showing extensive timber harvest, 1975.

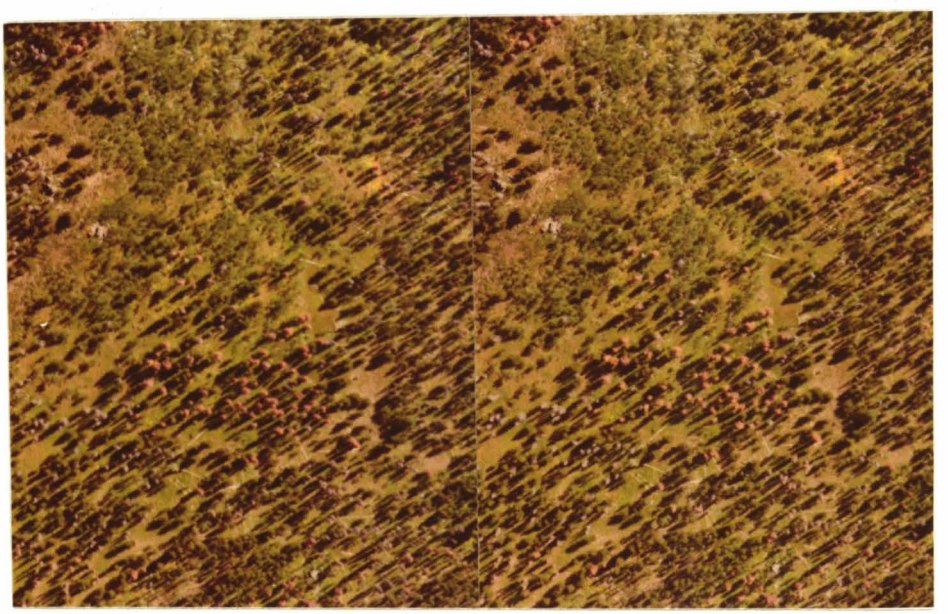

Figure 3. Vertical stereogram of plot 5-44 showing dead and fading lodgepole pine killed by the mountain pine beetle.

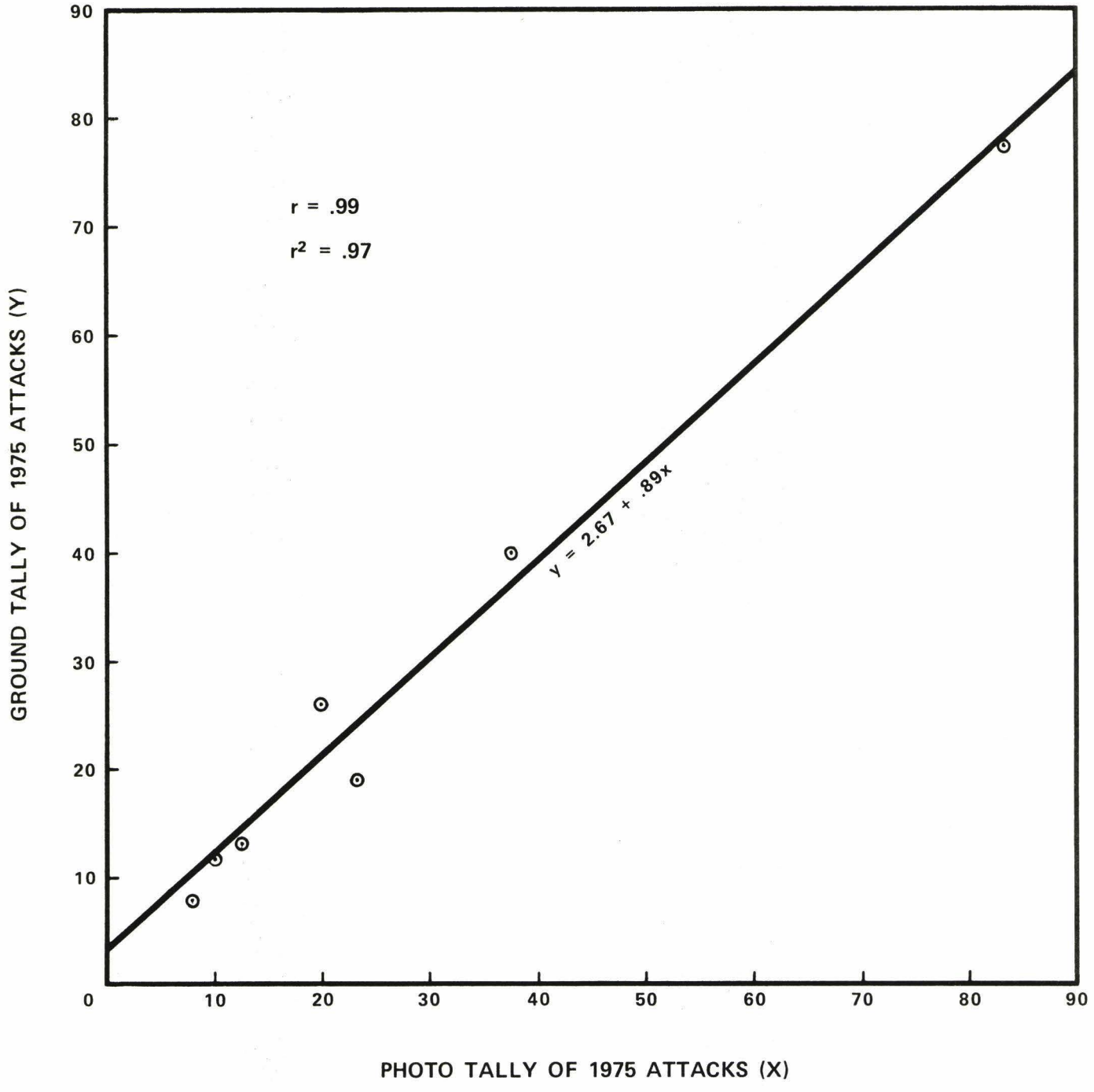

FIGURE 4. Comparison of Photo-to-Ground Counts of Lodgepole Pine Killed by the Mountain Pine Beetle - Moose Creek Plateau, Targhee National Forest

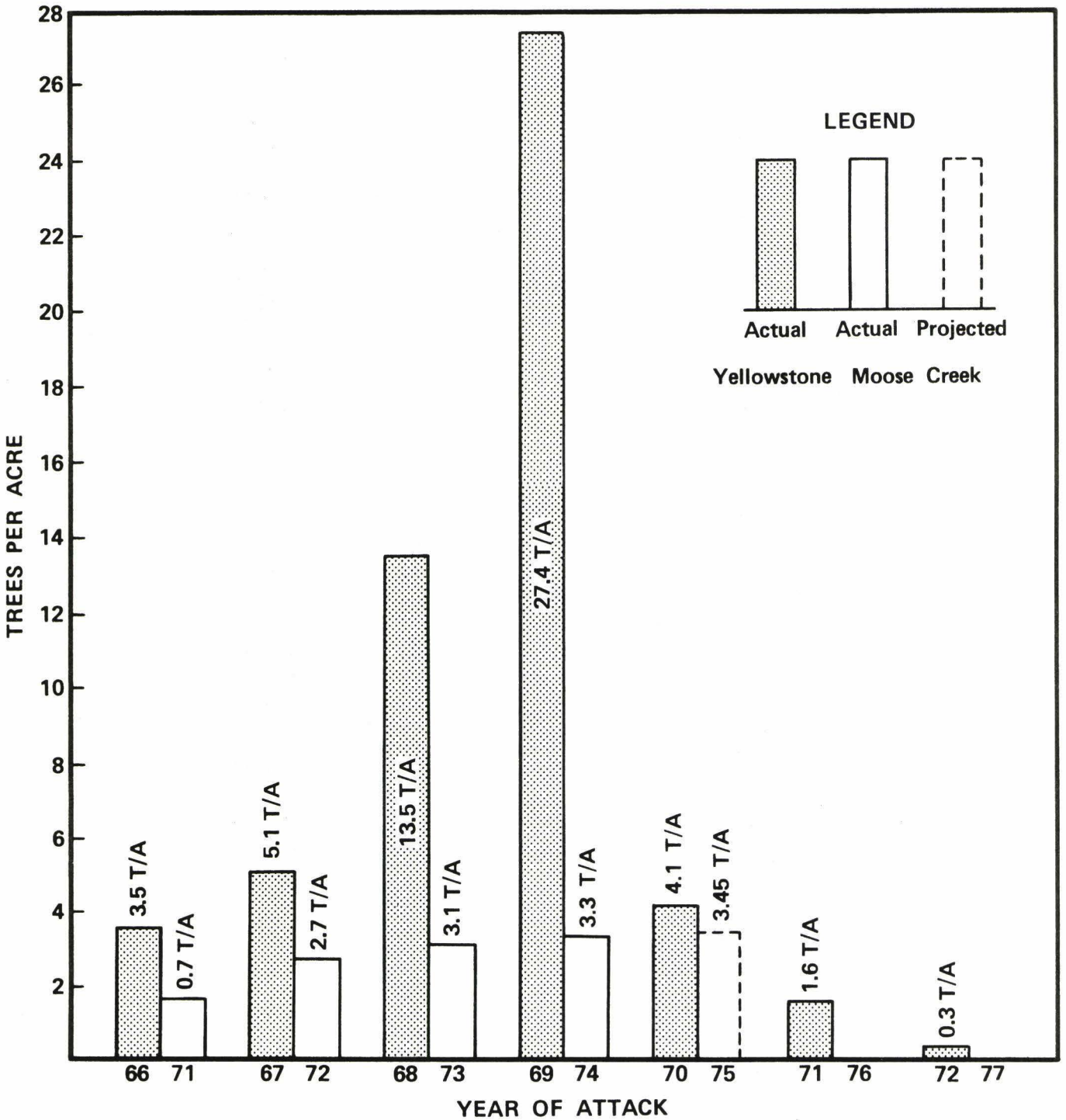

FIGURE 5. Comparison of the Annual Rate of Mountain Pine Beetle Caused Tree Mortality Between Yellowstone National Park and Moose Creek Plateau.